

PATENT

Atty. Dkt. No. APPM004714.C1/CPIW/CVD/PJS

REMARKS

This is intended as a full and complete response to the Final Office Action dated October 17, 2005, having a shortened statutory period for response set to expire on January 17, 2006. Please reconsider the claims pending in the application for reasons discussed below.

Claims 16-20, 23, and 26 remain pending in the application and are shown above. Claims 16-20, 23, and 26 are rejected by the Examiner. Reconsideration of the rejected claims is requested for reasons presented below.

Claims 16-18 and 20 stand rejected under 35 U.S.C § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700). The Examiner states that *Kang, et al.* teaches a method comprising forming a refractory metal nucleation layer, WN, by serially exposing said substrate to first and second reactive gases, wherein the refractory metal nucleation layer covers the via, and forming a bulk deposition layer on said nucleation layer by employing vapor deposition to bulk deposit a refractory metal contained in one of said first and second reactive gases, wherein the bulk deposition layer fills the via (column 6, lines 13+) and the refractory metal is tungsten (column 2, lines 65+). The Examiner acknowledges that *Kang, et al.* fails to explicitly teach that tungsten is the bulk deposition layer filling the via and takes "official notice" that the claimed subject matter is well-known in the art, as evinced by applicant's own admitted prior art (paragraphs [0005]-[0006]) of the specification and *Chang, et al.* (U.S. Patent No. 5,028,565). The Examiner concludes "Therefore, Kang's teaching (6, 13+) that a tungsten CVD chamber can be added to the cluster tool can be used for the bulk deposition of tungsten in to the via." Applicants respectfully traverse the rejection.

Applicants submit that paragraphs [0005]-[0006] of the instant specification teach that tungsten CVD processes have been used in semiconductor processes. *Chang, et al.* teaches that CVD tungsten has become a preferred metal for filling vias (column 1, lines 20-24). Thus, Applicants agree with the Examiner that bulk deposition of tungsten into a via has been described. However, Applicants note that the pending claims recite a method that requires more than simply bulk depositing tungsten into vias. The pending claims also specify that the bulk deposition layer is deposited on a refractory

PATENT

Atty. Dkt. No. APPM/004714.C1/CPI/WCVD/PJS

metal nucleation layer that is formed by serially exposing the substrate to first and second reactive gases or compounds.

Kang, et al. describes a process comprising forming a WN metal barrier layer on a substrate by atomic layer deposition using a tungsten containing precursor (column 2, line 65+), but does not describe bulk depositing a tungsten layer on the WN metal barrier layer, wherein the tungsten layer fills vias in the substrate. The Examiner is relying on 1) *Kang, et al.*'s description that the WN metal barrier layer may be formed on "a cluster tool that can further include a conventional AI-CVD chamber for forming a subsequent metal line, a W (tungsten)-CVD, and a degassing chamber" (column 6, lines 13-16) and 2) a previously described use of CVD tungsten to fill vias (*Chang, et al.*, column 1, lines 20-24) to assert that the tungsten CVD chamber of *Kang, et al.* can be used for the bulk deposition of tungsten into the via of *Kang, et al.* Applicants respectfully submit that a description of forming one layer on a cluster tool that may include several other chambers that can be used to perform known processes does not provide a suggestion or motivation to form the one layer, *i.e.*, the WN metal barrier layer of *Kang, et al.*, and then perform a particular process that can be executed by one of the chambers, *i.e.*, bulk depositing tungsten to fill vias. Applicants submit that the Examiner is using impermissible hindsight to find a suggestion of the combination of elements as claimed.

Therefore, *Kang, et al.* does not teach, show, or suggest a method for forming a nucleation layer and a bulk deposition layer on a substrate having a plurality of vias, said method comprising forming a refractory metal nucleation layer by serially exposing said substrate to first and second reactive gases, wherein the refractory metal nucleation layer covers the plurality of vias, and forming a bulk deposition layer on said nucleation layer by employing vapor deposition to bulk deposit a refractory metal contained in one of said first and second reactive gases, wherein the bulk deposition layer fills the plurality of vias, and wherein the refractory metal is tungsten, as recited in claim 16. Applicants respectfully request withdrawal of the rejection of claim 16 and of claims 17-18 and 20, which depend thereon.

Claim 19 stands rejected under 35 U.S.C § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No.

Page 6

414037_1.DOC

PATENT

Atty. Dkt. No. APPM/004714.C1/CPI/WCVD/PJS

6,287,965). The Examiner states that *Kang, et al.* (U.S. Patent No. 6,139,700) fails to teach diborane as a first reactive gas and that *Kang, et al.* (U.S. Patent No. 6,287,965) does not specifically state that the boron for forming an ALD WBN layer is supplied by diborane or any other boron compound, but the examples of *Kang, et al.* for forming a TiAlN layer provide components as compounds. The Examiner concludes that one would easily surmise that a boron compound would be used to supply the boron to the layer, especially in view of *Takagi, et al.* (U.S. Patent No. 6,107,200, abstract) and *Authier, et al.* (U.S. Patent No. 4,113,532, column 2, lines 29-39). Applicants respectfully traverse the rejection.

Claim 19 includes the limitations of proposed claim 16. As discussed above, *Kang, et al.* (U.S. Patent No. 6,139,700) does not provide or suggest all of the limitations of claim 16. Applicants further submit that *Kang, et al.* (U.S. Patent No. 6,287,965) does not teach or suggest bulk depositing a refractory metal, *i.e.*, tungsten, on a refractory metal nucleation layer, *i.e.*, tungsten, that is formed by serially exposing a substrate to first and second reactive gases.

Takagi, et al. describes using diborane to deposit a tungsten film (abstract). *Authier, et al.* describes using diborane to deposit a metal boride layer (column 2, lines 38-39). However, neither *Takagi, et al.* nor *Authier, et al.* teaches or suggests bulk depositing a tungsten layer on a refractory metal nucleation layer that is formed by serially exposing a substrate to first and second reactive gases, wherein the bulk deposited tungsten layer fills vias in the substrate. Applicants further submit that *Kang, et al.* (U.S. Patent No. 6,139,700), *Kang, et al.* (U.S. Patent No. 6,287,965), *Takagi, et al.*, and *Authier, et al.*, individually or in combination, do not provide or suggest all of the limitations of claim 16, and thus, do not provide or suggest all of the limitations of claim 19. Applicants respectfully request withdrawal of the rejection of claim 19.

Claims 23 and 26 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Kang, et al.* (U.S. Patent No. 6,139,700) in view of *Kang, et al.* (U.S. Patent No. 6,287,965) on grounds that it would have been obvious to bulk deposit tungsten on the WN layer of *Kang, et al.* (U.S. Patent No. 6,139,700), use the WBN layer formed by atomic layer deposition in *Kang, et al.* (U.S. Patent No. 6,287,965) in place of the WN layer of *Kang, et al.* (U.S. Patent No. 6,139,700), and use a boron-containing compound

PATENT

Atty. Dkt. No. APPM004714.C1/CP/WCVD/PJS

to supply the boron of the WBN layer in view of *Takagi, et al.* (U.S. Patent No. 6,107,200, abstract) and *Authier, et al.* (U.S. Patent No. 4,113,532, column 2, lines 29-39). Applicants respectfully traverse the rejection.

While *Kang, et al.* (U.S. Patent No. 6,139,700) describes depositing WN layers, *Kang, et al.* (U.S. Patent No. 6,139,700) does not teach or suggest depositing nucleation layers using a boron-containing compound and a tungsten-containing compound or depositing a bulk layer comprising a refractory metal from a boron-containing compound or a tungsten-containing compound on a nucleation layer deposited by using the boron-containing compound and the tungsten-containing compound. *Kang, et al.* (U.S. Patent No. 6,287,965) provides layers that may include boron, but does not teach or suggest depositing a bulk layer comprising a refractory metal from a boron-containing compound or a tungsten-containing compound on a nucleation layer deposited by using the boron-containing compound and the tungsten-containing compound. Applicants further submit that *Takagi, et al.* and *Authier, et al.*, individually, or in combination with *Kang, et al.* (U.S. Patent No. 6,139,700) and *Kang, et al.* (U.S. Patent No. 6,139,700) do not teach or suggest depositing a bulk layer comprising a refractory metal from a boron-containing compound or a tungsten-containing compound on a nucleation layer deposited by using the boron-containing compound and the tungsten-containing compound. Thus, *Kang, et al.* (U.S. Patent No. 6,139,700), *Kang, et al.* (U.S. Patent No. 6,287,965), *Takagi, et al.*, and *Authier, et al.*, individually or in combination, do not provide or suggest all of the limitations of claims 23 and 26. Applicants respectfully request withdrawal of the rejection of claims 23 and 26.

Claims 16-20, 23, and 26 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,620,723 in view of *Wolf*, Silicon Processing for the VLSI Era: Volume 2-Process Integration, 1990, pp. 192-194. The Examiner acknowledges that the conflicting claims are not identical to the present claims because the present claims do not specify that the nucleation layer is a boride layer, and the present claims add the bulk deposition layer. The Examiner asserts that the forming of a bulk deposition layer

PATENT

Atty. Dkt. No. APPM004714.C1/CPW/CVO/PJS

is an obvious next step after forming a nucleation layer. Applicants respectfully traverse the rejection.

As discussed above with respect to the 35 U.S.C. § 103(a) rejections of claims 16-20, 23, and 26, the Examiner has not shown a suggestion or motivation to bulk deposit a refractory metal, *i.e.*, tungsten, on a refractory metal nucleation layer, *i.e.*, tungsten, that is formed by serially exposing a substrate to first and second reactive gases, and thus has not shown that the pending claims are *prima facie* obvious. Applicants respectfully submit that claims 16-20, 23, and 26 should not be rejected under obviousness-type double patenting over claims 1-4 of U.S. Patent No. 6,620,723, as claims 16-20, 23, and 26 have a separate basis for patentability, *e.g.*, the combination of the bulk deposition layers and refractory metal nucleation layers as claimed. Applicants respectfully request withdrawal of the rejection of claims 16-20, 23, and 26.

Claims 16-20, 23, and 26 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-34 of U.S. Patent No. 6,831,004. The Examiner acknowledges that the conflicting claims are not identical to the present claims because the present claims do not specify that the nucleation layer is a boride layer and the present claims add the bulk deposition layer. The Examiner asserts that the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer. Applicants respectfully traverse the rejection.

As discussed above, the Examiner has not shown a suggestion or motivation to bulk deposit a refractory metal, *i.e.*, tungsten, on a refractory metal nucleation layer, *i.e.*, tungsten, that is formed by serially exposing a substrate to first and second reactive gases, and thus has not shown that the pending claims are *prima facie* obvious. Applicants respectfully submit that claims 16-20, 23, and 26 should not be rejected under obviousness-type double patenting over claims 1-34 of U.S. Patent No. 6,831,004, as claims 16-20, 23, and 26 have a separate basis for patentability, *e.g.*, the combinations of the bulk deposition layers and refractory metal nucleation layers as claimed. Applicants respectfully request withdrawal of the rejection of claims 16-20, 23, and 26.

PATENT

Atty. Dkt. No. APPW004714.C1/CPI/WCVD/PJS

Claims 16-20, 23, and 26 stand provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925. The Examiner acknowledges that the conflicting claims are not identical to the present claims because the present claims do not specify that the nucleation layer is a boride layer and the present claims add the bulk deposition layer. The Examiner asserts that the forming of a bulk deposition layer is an obvious next step after forming a nucleation layer. Applicants respectfully traverse the rejection.

As discussed above, the Examiner has not shown a suggestion or motivation to bulk deposit a refractory metal, *i.e.*, tungsten, on a refractory metal nucleation layer, *i.e.*, tungsten, that is formed by serially exposing a substrate to first and second reactive gases, and thus has not shown that the pending claims are *prima facie* obvious. Applicants respectfully submit that claims 16-20, 23, and 26 should not be rejected under obviousness-type double patenting over claims 1-28 of co-pending U.S. Patent Application Serial No. 10/993,925, as claims 16-20, 23, and 26 have a separate basis for patentability, *e.g.*, the combinations of the bulk deposition layers and refractory metal nucleation layers as claimed. Applicants respectfully request withdrawal of the rejection of claims 16-20, 23, and 26.

In conclusion, the references cited by the Examiner, alone or in combination, do not teach, show, or suggest the invention as claimed.

Having addressed all issues set out in the Final Office Action, Applicants respectfully submit that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,



Keith M. Tackett
Registration No. 32,008
PATTERSON & SHERIDAN, L.L.P.
3040 Post Oak Blvd. Suite 1500
Houston, TX 77056
Telephone: (713) 623-4844
Facsimile: (713) 623-4846
Attorney for Applicant(s)